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THE DIAGNOSIS AND TREATMENT OF FRACTURE OF THE CARPAL SCAPHOID AND DISLOCATION OF THE SEMILUNAR BONE.

WITH A REPORT OF THIRTY CASES.

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It is proposed to consider the subjects included in the title of this paper under the following heads:

I, Introduction. II, Development of the Carpal Bones. III, Symptoms of Simple Fracture of the Scaphoid Bone. IV, Diagnosis. V, Use of the X-ray in Diagnosis. VI, Treatment of the Fractures of the Scaphoid. VII, Report of Cases. The remarks upon these groups constitute the present paper. In a second paper will be presented, I, Dislocation of the Semilunar Bone. II, Symptoms. III, Treatment. IV, Report of Cases. V, *Résumé* of Literature of Carpal Injuries in General. VI, Diagnosis and Treatment. VII, Report of Cases. VIII, Conclusions. IX, Bibliography.

PART I.

INTRODUCTION.

The first case of simple fracture of the scaphoid bone of the wrist in which I was able to make a diagnosis was that of J. G. (Case I), which is herewith reported. For the privilege of reporting this case, as well as several others, I am indebted to Dr. Franklin G. Balch, in whose Clinic at the Massachusetts General Hospital J. G. was treated. In this instance the diagnosis was considered a simple sprain, but the continued symptoms led us at length to examine the wrist with the fluoroscope, and the fracture was then easily recognized. During the next four years occasional examples of this lesion presented themselves at the Clinic, but it was not until a private case (Case V) came to me in December, 1901, that I fully appreciated the importance of this fracture. The failure of rest, time, massage, and, finally, of forcible manipulation to restore the perfect functions of this young man's wrist, has led me to study with great care all the other cases of carpal injuries which I have met in my hospital work. As a result of this study, I now recommend excision of one or both portions of the broken scaphoid. The cases herewith reported have nearly all been at my own Out-Patient Clinic; but for a few I am indebted to my colleagues, who, knowing my interest in injuries to the wrist, have referred them to me. Besides the cases here reported, there have been many others which I have seen once or twice and which help to form the experience on which this paper is based. Dr. Chase and I have, however, felt that partial reports of such cases would be superfluous, because the ultimate results have not been observed or because the X-rays have been obscure and doubtful. We have, therefore, selected those cases to report which we have in most instances been able to observe for some months or years after their original injury.

My interest in this subject is also greatly quickened by a friendly discussion with Professor Thomas Dwight, in which a radical difference of opinion has arisen as to the nature of

these fractures of the scaphoid. My views have been based on my clinical and X-ray experience, and I consider these lesions as entirely due to trauma acting on normal bones. I explain the non-union by the anatomical situation of the bone, which allows the fractured surface to be persistently bathed in synovial fluid, and by the lack of proper and continued fixation immediately after the injury. Professor Dwight, looking at the subject from a developmental and anatomical point of view, explains these lesions as instances of bipartite centres of ossification which never unite by a true bony union, and thus are easily separated by violence. In an address to the Massachusetts Medical Society, his words, referring to certain anomalies in the formation of bones, are as follows: "This naturally suggests the burning question of fracture of the scaphoid bone of the wrist, which I think no one had ever heard of before the X-ray. Now it occurs all the time. My friend Dr. Codman was kind enough a while ago to show me a room full of patients with fractured scaphoids at the Massachusetts General Hospital; and yet I still believe that, putting aside extraordinary cases of injury, a normal scaphoid is never broken, and that the separation into two parts, which undoubtedly occurs, is the result of violence acting on a bone composed of two pieces united merely by cartilage. This also I hope before long to establish." Certain bipartite scaphoids which Professor Dwight finds in the dissecting-room, he considers as examples of such faults of development, while from my point of view they are merely instances of the fairly common lesion of fracture of the scaphoid (Plate IV, Fig. 12).

In following up this subject, another lesion of the wrist of slightly less frequent occurrence has been met with, and it has seemed to us necessary to include this with simple fracture as it sometimes accompanies it. We have, therefore, included dislocation of the semilunar bone under the scope of this paper, particularly since a method of reduction, devised by one of us in pursuance of some anatomical studies of the normal motions of the wrist-joint, has been used with signal success in three cases.

During our study of these two typical lesions, *i.e.*, simple fracture of the scaphoid and dislocation of the semilunar bone, we have met with a few other instances of fractures of the small bones of the carpus; but, since they were extremely rare, we have left them out of the discussion, feeling that it is more important to call the attention of the profession to these two more common lesions, which are really so often met with that they should be borne in mind by every practitioner, and are by no means to be considered as curiosities.

That error in the diagnosis and treatment of these injuries is frequent is well illustrated by four articles which have appeared in this Journal during the last four years. I refer to those by Bolton, Stimson, Hessert, and Ely, criticism of whose papers, except that by Bolton, will be found in the footnotes in Part II under names of Stimson, Hessert, and Ely.

In Bolton's case, as in the others, the error is one of interpretation of the skiagraph, which shows, in addition to the obvious dislocation of the semilunar, a coincident fracture of the scaphoid bone. (E. A. C.)

DEVELOPMENT OF THE CARPAL BONES.

It is not our intention to enter into the discussion of the detailed comparative anatomy or embryological history of the centres of ossification of the carpal bones, but we feel that a brief mention of the theory of Pfitzner is important in giving a fair presentation of our views on the relative frequency of fracture of the scaphoid and of a congenital bipartite condition of this bone. Pfitzner, having studied the types of arrangement of the carpal bones in the lower animals, has elaborated the following typical scheme of the probable centres of ossification, the fusion or coalescence of which forms the variations in different species. This scheme conceives the formation of cartilaginous centres, twenty-four in number, which represent the possible number of carpal bones which may develop through the independent ossification of each centre. Variations from this type are caused by disappearance of certain centres, by absorption, by absence of ossification, and by fusion or

coalescence of the different elements. This may be more clearly appreciated by reference to the accompanying diagrams of Pfitzner (p. 326), which represent the cartilaginous centres of the possible bones of the carpus and suggest two interesting considerations.

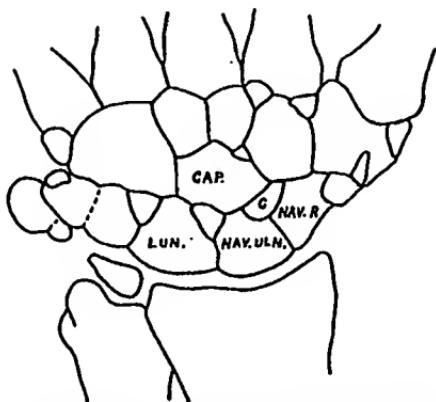
First, an arrangement roughly into five rows suggests its homologous relation to its ancestral types; second, the number of centres represent the possible number of the adult carpal bones, some of which, as a rule, disappear, and do not continue development to ossification, while others either coalesce and form a process or continue an independent existence as a separate bone.

The ages at which the centres of ossification of the carpal bones appear have been recorded by Debierre as follows:

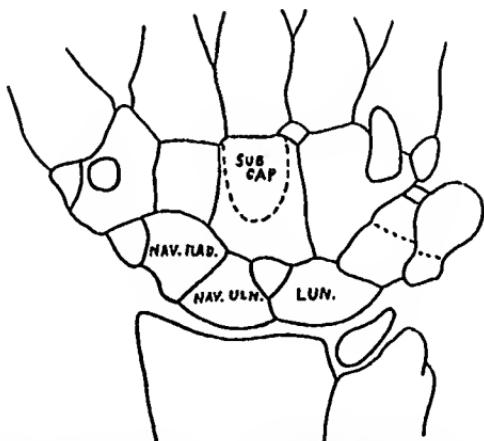
Os magnum, 11 to 12 months; unciform, 12 to 14 months; unciform, 3 years; semilunar, 5 to 6 years; trapezium, 6 years; scaphoid, 8 years; trapezoid, 6 to 7 years; pisiform, 10 to 13 years. But these have been found to occur somewhat earlier since the use of the X-ray, and both observations suggest that we must not expect fracture to show in early life.

Pfitzner emphasizes the rationality of his theory by showing several instances of variation in which a single centre of ossification is found in each of three specimens, either as a distinct bone or coalesced to one of its adjacent carpal bones forming a bone process. He stated also that, although he had never seen a separate centre for a bone which he called the subcapitatum (marked Subcap. on the diagram), he nevertheless was firmly convinced that it must exist in harmony with the rationality of his theory and practically proven scheme of the development of carpal bones. This great anatomist died without ever having seen this one separate bone, the subcapitatum, which he prophesied must exist. He described the subcapitatum as lying on the palmar side of the hand between the trapezoid and the unciform bones, synostosed with the distal portion of the os magnum and articulating with the third metacarpal. This bone was first recognized and beautifully

demonstrated by Professor Thomas Dwight in both hands of a white man aged fifty-four years, thus adding another con-



Pfizer's diagram. Dorsal view. NAV. R., Navicular Radiale. NAV. ULN., Navicular Ulnare. C., Centrale. LUN., Lunatum. CAP., Capitatum.



Pfizer's diagram. Ventral view. NAV. RAD., Navicular Radiale. NAV. ULN., Navicular Ulnare. LUN., Lunatum. SURCAP., Subcapitatum.

sfirmation of Pfizer's scheme and speaking loudly for its acceptance.

To speak now more particularly of the possibilities of variation of the scaphoid bone, we refer to Pfitzner's diagram of the navicular (scaphoid), which he has termed the navicular radiale and navicular ulnare in harmony with his view of two centres. It is the development of a centre of ossification in each navicular radiale and ulnare that gives rise to the so-called bipartite scaphoid; and it is the additional centre of ossification in the centrale which gives rise to the more rare condition of tripartite scaphoid.

Woolf considers two centres of ossification uncertain and not the rule, as Gruber thinks. American anatomies and embryologies state the rule as one centre. Serres recognizes Pfitzner's entire theory of three centres of the scaphoid, which as a rule unite to form one bone. Leboucq never saw more than one centre, which is of value, as he has made important discoveries about the development of the hand. Behrendsen and Von Ranke do not mention two centres. Von Wyss saw in cretins two centres in the scaphoid, but we do not know his view regarding normal individuals. Wilms never saw two centres from birth to adult. Gruber states that from 1869 to 1883 he saw 3007 scaphoids in which four were bipartite and one was tripartite. Since 1883 he speaks of 1000 scaphoids in one of which were traces of tripartite. Pfitzner in 1450 scaphoids saw one-half per cent. of entire divisions, but he does not make it clear that some, if not all, of these might not have been old fractures. Among the 1450 he also saw 2 per cent. to 3 per cent. of fissures. In looking through 1040 X-rays of wrists, we do not find any divided scaphoid which is not definitely associated with injury, even in those in which X-rays of both wrists were taken for comparison.*

It is our position in this paper that we have not sufficient knowledge of embryology or comparative anatomy to presume to argue with Professors Pfitzner and Dwight on their own

* There are three possible exceptions to this statement (Cases II, IV, IX). While in these cases the patient could give no history of injury, the presence of secondary arthritic changes and pronounced clinical symptoms speak strongly for the traumatic origin of the lesion.

grounds; yet it has not been made clear that a part, if not all, of the divided scaphoids above mentioned may not have been the result of old fractures. We do not wish to assume that variations do not occur; there is no reason to believe that nature does not vary in the formation of the carpal bones as well as in any other part of the body; but we do wish to show that while they may occur, and while we do have to consider the possibility of their presence in any case under observation, nevertheless, they are rare, much more rare than fracture. We wish the possibility of variation understood and appreciated to aid judgment in its interpretation of clinical history.

If the bipartite variation is sufficiently frequent to be a real cause for confusion with fracture, it is a surprising coincidence that no X-rays of wrists taken for other conditions, such as foreign bodies or injuries to the forearm and phalanges as well as many normal wrists taken unnecessarily in a large number of cases, show no bipartite scaphoids.

Woolf cites a case which harmonizes with our views of rare possibilities. It was one which he diagnosed as a bipartite scaphoid; it was bilateral; there was no history of injury; there were no disabling clinical symptoms; forcible abduction showed no dislocation of fragments. He concludes that a part of the so-called bipartite scaphoids are fractures without bony consolidation, simulating other intracapsular fractures. One can only accept the bipartite theory where the halves touch with smooth cartilaginous surfaces. In the cases in which we have operated this was not found to be the case.

The cases illustrating this paper we believe are positive fractures. We say positive, because their diagnoses are based upon a series of definite observations, supported by circumstances of causation, and associated with objective and subjective symptoms, giving a clinical picture which it is not reasonable to accept as happening fortuitously on a previously developed bipartite scaphoid, so accurately harmonizing in every detail with the particular right or left hand in which trauma and local symptoms coincide, and in none of which do both wrists show the same condition.

Variations exist and deserve recognition, but they do not exist so regularly and unilaterally as to coincide in each case with the associated cause of fracture, the objective and subjective symptoms, as to lead one to assume any selective motive for injury to the particular wrist containing a bipartite scaphoid.

In confirmation of our opinion, we find in some of our cases that union has occurred as shown strikingly by the X-rays in Case VI.

SYMPTOMS OF SIMPLE FRACTURE OF THE SCAPHOID BONE.

The cases of fracture of the scaphoid which are herewith reported have, with a very few exceptions, presented themselves from several months to many years after the original injury, so that the history and symptoms should more properly be considered as those of old ununited fractures of the scaphoid than of the recent injury. The typical history has been something like the following, and is frequently characteristic enough to permit of diagnosis even without the X-ray.

The patient, usually a male of from twenty-five to thirty-five years of age, has fallen on his extended wrist in the same manner as in the injury which usually causes a Colles fracture. He has supposed that he has sprained his wrist, and for a few days has suffered severe pain and tenderness and has been unable to use the hand for ordinary purposes. During a period varying from a few days to several weeks, according to the hardihood of the individual, he has refrained from using his wrist. Gradually he has been able to take up his work again, but after a certain point the soreness, tenderness, and disability have refused to improve, and perhaps he has suffered some similar injury a second time, and the symptoms have become aggravated again. Perhaps the mere mechanical effect of his work has kept the joint in a continued state of irritation. Eventually he comes to the hospital complaining of pain, tenderness, and weakness of his wrist. Examination shows that the fingers have their normal flexibility, but that the active

and passive motions of the wrist-joint are limited to one-half or less of their normal are of excursion. Attempts to continue passive motion beyond a certain point, especially in extension, are limited by a most characteristic muscle spasm very similar to that seen in tubercular joints. If the spasm is overcome by force and the wrist moved still further, the pain is intolerable. There is no crepitus or ecchymosis, but there is seen to be slight swelling or thickening over the radial half of the wrist-joint. The outlines of the extensor tendons of the thumb are made less distinct by the swelling, and pressure elicits signs of tenderness definitely localized over the scaphoid bone, and especially in the anatomical snuff-box. The X-ray shows a transverse fracture in the scaphoid.

As compared with the other wrist, a certain amount of alteration of the bony landmarks is found. The relation of the ulna and radial styloids is, of course, normal; but when the wrist is flexed, the prominence formed by the scaphoid just below the lower end of the radius is more pronounced than that of the other wrist and feels quite differently. This difference is, however, not striking enough to form the basis for a diagnosis unless taken with other symptoms. Treatment with counterirritants, massage, rest, forced motions under anaesthetics, etc., fail to bring about any considerable improvement in the condition, and the function of the wrist remains permanently though not greatly impaired.

In order to consider these symptoms more in detail, we have made an analysis of the accompanying eighteen cases which form the basis for the following observations.

Of the eighteen cases, the ages were as follows:

2 cases, 18 years.	1 case, 30 years.	2 cases, 39 years.
1 case, 19 years.	1 case, 31 years.	1 case, 40 years.
1 case, 20 years.	1 case, 32 years.	1 case, 41 years.
1 case, 25 years.	3 cases, 33 years.	1 case, 49 years.
1 case, 27 years.	1 case, 34 years.	

Not only all these cases, but all the others which we have seen, were in males of about the same ages. In thirteen of the eighteen cases the injury was to the right wrist.

Most of the patients were artisans in various trades involving more or less active work, the following occupations being represented: boiler-maker, electrician, shoemaker, cigar-maker, laborer, waiter, two clerks, machinist, electrotyper, hostler, railroad employé, artesian-well driller, dentist, two surgeons, yacht rigger, and student. With a few exceptions, all of the accidents occurred while these individuals were engaged in some athletic exercise, or the injuries were due to some accident not necessarily connected with their trade. In two instances only the injury was caused by direct violence, viz., in Case I, a kick in the wrist; in Case VIII, a marble slab fell on the wrist. In the other instances the injury was due to indirect violence or unknown causes, viz., in Case III, a fall from a bicycle; in Cases V and XV, in playing foot-ball; in Cases VI, X, XII, XIV, XVI, and XVII, from falls varying from one to twelve feet. In only eight cases were we able to obtain a history as to whether the injury occurred in extension or flexion of the wrist; in five of these it occurred in extension; * in the other three, viz., Cases VI, XIII, and XVIII, the patients *thought* that it occurred in flexion, although they were not certain. In every case the pain was at first intense and followed immediately by swelling and excessive tenderness. In nearly every case, the exceptions being those in which the X-ray was taken, the immediate diagnosis of the physician in attendance was "sprain."

Several cases did not consult a physician at all after the first injury, and only came under observation after the lapse of time had failed to relieve their pain and tenderness. In only three cases was there a continued fixation of the wrist in splints for more than a week; these were Cases VI, X, and XIII, which were the only cases which resulted in union. This fact is very important as emphasizing the tendency of active and

* If the reader will examine the extended wrist of a skeleton, he will see that a force exerted in the direct line of the axis of the radius must be transmitted through the scaphoid. Blau has pointed out that such a force will tend to break the scaphoid at its weakest portion, *i.e.*, the neck, which by such force is brought to bear against the styloid of the radius.

passive motions to prevent union, because in all the other cases in which fixation was not maintained union did not occur. Many of the cases complained of secondary injuries which had brought on much the same symptoms as those suffered at the original injury. Cases I, III, V, VII, VIII, XI, XII, and XV are instances of this.

In the majority of the cases the fracture had occurred at almost exactly the middle of the scaphoid, but in five cases, viz., IX, XIV, XV, XVI, and XVII, it occurred at the junction of the middle and proximal third. We are not able to say whether this form of fracture is more or less serious than that of the transverse fracture at the middle of the bone. In either case there seems to be very little tendency towards displacement. In both of the operated cases the displacement was barely perceptible.

As a rule, the patients complain that the forms of motion which cause pain are those which involve pushing with the extended hand or twisting, *e.g.*, opening heavy doors, turning door-knobs, rising from a chair and using the extended hand on the arms of the chair to help in lifting the weight, rowing, playing games, as foot-ball or tennis, fooling with other men, unexpected twists of the wrist, etc. The disability may seriously interfere with the patient's work; for instance, J. G., Case I, is a boiler-maker,—the wrist bothers him most of the time; Case II is a shoemaker,—he is continually troubled with it; Case III is an electrician,—he finds it very inconvenient in using a screw-driver and in writing; Case XIV is a dentist,—he finds his wrist extremely painful in grasping his instruments, especially in pulling teeth.

The tenderness in all the cases was very characteristic, being definitely localized in the scaphoid bone itself, and being especially acute in the anatomical snuff-box. If, in an uninjured adducted hand, the thumb of the examiner be pressed just below the styloid process of the radius in the anatomical snuff-box, the patient will feel an acute tenderness from the pressure on a branch of the radial nerve against the scaphoid bone. This "normal tenderness" is, however, bearable even

if great pressure is made. On the other hand, if the scaphoid is broken, even if the injury occurred many years before, the tenderness in the snuff-box will be too great to be borne without wincing, and the patient will usually try to withdraw his hand. As a matter of fact, when the wrist is adducted and pressure made in the snuff-box, the point touched is almost exactly the middle third of the bone where the fracture occurs. Although the tenderness is most marked in the anatomical snuff-box, there is often found in old cases tenderness over the dorsal portion of the scaphoid. Tenderness in this region is, however, much less acute, and is scarcely more noticeable than in the other portions of the wrist. In a number of cases tenderness over the unciform bone has also been noticed. We have been unable to account for this. Curiously enough the scaphoid tubercle does not seem to be at all tender, and even when firm pressure is made on the tubercle, no pain is caused. This is probably due to the fact that the tubercle is so firmly held by its ligamentous attachments that the position is not changed by pressure.

The swelling in both acute and old cases is in very much the same distribution as the tenderness, being more distinct on the radial half of the wrist and especially about the tendons bounding the snuff-box. There is usually no great swelling, but on comparison with the other wrist there is no difficulty in seeing it. Immediately after the injury there is usually a great deal of swelling of the wrist and dorsum of the hand, so that the diagnosis may be found more difficult than in old cases where the tenderness and swelling are more definitely localized in the scaphoid region. *In no case have we found crepitus or ecchymosis*, although in a few cases the patients themselves have said that the wrist was black and blue soon after the injury. Since very few of the cases have come to us at this stage, we are unable to speak very positively on this point. Most of our cases have come after some secondary injury, the original fracture having occurred some years before. In no case do we recall giving a patient ether and manipulating the wrist forcibly in order to obtain crepitus.

We have been satisfied with the clinical and X-ray diagnosis, and have not thought it necessary to use ether. We are inclined to think that crepitus and ecchymosis seldom, if ever, occur in simple fracture of the scaphoid. The reason for the absence of ecchymosis is that what bleeding there is from the broken bone must go directly into the joint, the capsule of which would not let it escape, thus preventing extravasation of blood from appearing under the skin. The absence of crepitus is due to the accurate fitting of the bones of the wrist, which permits only the slightest possible degree of motion of the fragments. This was beautifully demonstrated in our two operations, where on manipulating the wrist only a very slight play of the fragments was observed.

DIAGNOSIS OF SIMPLE FRACTURE OF THE SCAPHOID.

The consideration of the eighteen cases which we present shows that in the majority the first diagnosis in these injuries has been that of an ordinary sprain, and in the few instances where the diagnosis was at once made, it was confirmed by the skiagraph. We, however, feel that in many of these cases the diagnosis could have been quite positively made on the clinical symptoms; in fact, we have in a few cases made the diagnosis positively before our skiagraph was taken. It must be admitted, however, that in other cases we have been in doubt. For instance, in the following case:

P. F., aged seventeen years; school-girl. This patient, while bowling at cricket in the spring of 1902, in England, felt something snap in her wrist. There was immediate and intense pain and inability to move the fingers or wrist. There was local tenderness and swelling in the region of the scaphoid, and all attempts at motion were very painful. She saw a physician at once, who diagnosed it a sprain, and put her wrist on a splint, and put the arm in a Velpeau bandage with the arm and splint lying across the chest. The wrist was kept in this position for six weeks, and when the splint was removed she could scarcely move her fingers at all. Under massage and similar treatment she slowly recovered the use of her fingers, but the wrist has never been entirely well since.

Six or seven times in the past two years she has injured it less severely, and each time it has been accompanied with intense pain. Six weeks ago, while getting off an electric car, she injured it again, not by falling, but by twisting it as she held the railing in getting off the car.

Examination on May 12, 1904, showed the faintest possible swelling in the region of the scaphoid and marked tenderness over the whole region, particularly in the snuff-box. When her wrist was flexed there was a difference in the contour of the bony landmarks. She could flex the wrist about three-quarters the normal arc and extend it a little over half. Adduction and abduction were about four-fifths the normal. She said that it interfered in writing, in practising her music, and almost everything that she did with her hand. The X-ray showed no definite indication of any injury to the scaphoid.

In this case the clinical history and examination tally very well with fracture of the scaphoid, but the X-ray showed no indication of it. Since, however, the X-ray was not taken until two years after the injury, and at the time of the injury the wrist was kept for a long period in fixation, it is possible that fracture did occur and union took place as in Cases VI and VII. Although union may have taken place, some little distortion of the scaphoid bone may have remained, causing imperfect function of the wrist-joint and the pain of which this young woman complained.

In our experience, cases of sprained wrists, which have been shown by the X-ray to have no fracture, have recovered promptly, that is, within a few weeks; therefore, in the diagnosis from sprain, besides the local tenderness, extensor spasm, etc., we may say that the persistence of the symptoms speaks strongly for fracture of the scaphoid. We cannot feel sure, however, that some cases of fracture do not occur in the scaphoid which run a more favorable course and are soon followed by union and complete restoration of function. From our experience, however, we feel that non-union and disability, as a rule, result.

Besides simple sprain of the wrist, there have been other

cases in which a fracture or fissure in the lower end of the radius have made us suspect fracture of the scaphoid. In these cases, however, careful palpation will almost invariably show that the maximum point of tenderness is on the lower end of the radius and not on the scaphoid. Another point which may assist in this diagnosis is a fact which one of us (E. A. C.) has called attention to in a previous publication, *i.e.*, the sudden appearance of fluctuation in the common bursa or sheath of the tendons of the extensor carpi radialis brevior and longior and extensor secundi internodii pollicis. As this bursa has for its base the periosteum on the posterior part of the lower end of the radius, a crack, either longitudinal or transverse, in this portion of the radius is apt to rupture the base of the bursa, and bleeding takes place into the bursa without appearing as ecchymosis in other parts of the wrist. The result is a tense, fluctuating swelling of rather triangular shape overlying the radial half of the wrist-joint, and extending somewhat up on the lower end of the radius on its dorsal aspect. Since the bursa is thick-walled, the color of the blood does not show through. We have come to regard the presence of this engorged bursa immediately after an injury to the wrist as diagnostic of a fracture or fissure of the lower end of the radius. It is most common in Colles fracture, but may also merely represent a fissure in which there is no displacement of the fragments. In a complete Colles fracture it is sometimes so badly torn that the blood escapes from it, and hence it does not appear fluctuant. Curiously enough, although the presence of this engorged bursa does not speak for fracture of the scaphoid, it nevertheless anatomically overlies the scaphoid region, and pressure over it causes pain which may be mistaken for pain due to pressure on the scaphoid. We have occasionally also seen this phenomenon in the bursa of the extensor metacarpi pollicis and primi internodii pollicis which form the other boundary of the snuff-box. In making the diagnosis of fracture of the scaphoid as distinct from Colles fracture, one must not forget that both lesions may exist at the same time. We have seen a number of instances of this.

In fracture of the scaphoid the relations of the styloids are normal. We have also seen cases which have been complicated by fracture of the base of the metacarpal of the thumb.

In the cases which present themselves long after the injury, confusion with the different forms of arthritis is apt to arise in making the diagnosis. In fact, in such cases the natural diagnosis, unless the history of the injury was definitely recounted by the patient, would be osteoid arthritis. Against this diagnosis, however, we usually find that the patient is rather young, and that his other joints show no evidence of this disease. A careful questioning will bring out the history of a definite injury. Then, too, examination invariably shows the characteristic tenderness in the snuff-box and spasm in forced extension of the wrist. In two cases we recall confusing the lesion with tuberculosis of the wrist; but the absence of the history of the injury and the presence of the local heat, the character of the spasm, and, finally, the location of the tubercular focus by the X-ray, served to make the diagnosis.

In certain cases of inflammatory bursitis of the carpal tendon sheaths confusion might also arise, as these sheaths, as we have said in speaking of haemorrhage in them, overlie the region of the scaphoid. In such cases, however, the history points to over-use rather than to any injury to the wrist. The location of the tenderness along the courses of the sheaths themselves, rather than deep in on the bone, and the presence of the characteristic crepitus of tenosynovitis suffice to differentiate this lesion.

THE USE OF THE X-RAY IN DIAGNOSIS.

Owing to the peculiar shape of the scaphoid and to the obliquity of the angle with which its long axis lies in relation to the bones of the arm and hand, the appearance it gives in the X-ray is extremely apt to be deceptive. The diagnosis made on the X-ray alone should be made with the utmost caution, and only considered positive when a good view of the bone at right angles to its long axis is obtained.

The scaphoid is shaped roughly like a peanut, and lies, when the hand is laid prone upon a photographic plate, with its long axis at an angle of about 45° with the sagittal, vertical, and horizontal plane. Therefore, to obtain a skiagraph of the scaphoid which shall not be distorted, the tube should be in front, above and to the inner side of the wrist. Even when this precaution is taken, there will still be a slight distortion, because the proximal end of the scaphoid is at a greater distance from the plate than the distal end. The result of this will make the shadow of the proximal end larger than that of the distal end. This latter distortion may be obviated to a certain extent by adducting the wrist. This extends the scaphoid bone, that is, it lifts the distal end so that it comes nearer the plane of the proximal end. In abduction, however, the obliquity is increased and the long axis of the bone stands much more nearly vertical to the plane of the plate. The effect of taking a skiagraph in this position is to throw the shadow of one-half of the peanut so that it overlaps the other half. Since the neck between the two halves does not show, this will give the appearance of two separate pieces, one lying over the other.

If the reader will hold between his thumb and forefinger an ordinary peanut and look at it laterally, so that he can see the long axis at its maximum, he will see the best position in which to take a skiagraph of the scaphoid. If he then rotates the peanut so that its long axis becomes more and more oblique until it is vertical and points directly towards his eye, he will be able to see that the skiagraph will throw the shadows of the two halves of the peanut as separate objects if taken from this point of view.

A practical way to obtain a good picture of the scaphoid is to place the two wrists of the patient in adduction, and to place the tube in a position over the midline between the two hands, as far forward as the level of the knuckles.

Another point which it is well to bear in mind in making the diagnosis of fracture of the scaphoid is the existence of two more or less prominent bony ridges on the neck of the

scaphoid bone which bound the edges of the articular surfaces. These ridges in some cases are very prominent, and as the neck of bone between these two ridges is the thinnest portion of the bone, it is apt to give the appearance of a fracture, unless the X-ray is good enough to show the detail definitely. If the X-ray picture is taken correctly, and a good view of the bone in its long axis obtained, a positive diagnosis can readily be made, for not only can the line of fracture be seen, but often the exact region of the interruption to the trabecular structure of the bone.

It is often very difficult to determine the exact obliquity of the plane of the fracture. This can only be determined by taking a skiagraph which will pass directly through the line of fracture and show an interval between the fragments where there is no overlapping of the two portions. In the two cases in which we operated, we unfortunately did not make a special effort to determine this, and the X-rays taken before operation merely showed that there was a line of fracture and that the two fragments overlapped. At the operation the cleavage was found to run in such a direction that on looking into the wound, after removal of the proximal fragment, the raw surface of the distal portion formed the bottom of the cavity and faced the median line of the dorsum of the wrist. To make the diagnosis positive, one should always take more than one, better three or four skiographs from different angles so as to catch the exact plane of the fracture if possible.

From the X-ray appearance we may also form an approximate idea of the time since the fracture has taken place; at least, we may tell whether it has occurred within a few weeks or took place months or years previously. One seldom sees any effort at callus formation, but occasionally this does take place. In Case IV we have a series of X-rays which show a slight callus formation which has increased in amount at intervals of many months. As a rule, the secondary joint changes in other portions of the wrist are more obvious than callus formation of the fracture itself, and one may see on the adjacent surface of the radins and carpal bones little osteophites or liplike formations at the edges of the articular sur-

faces. These do not form until some months or years after the fracture has occurred, and represent the reaction to the mechanical irritation of the displaced fragments. This condition is more pronounced in individuals who are obliged to use their wrists a great deal in their occupations. It has the same general appearance as osteoid arthritis. (I recall making the diagnosis of osteoid arthritis in one of my early cases of fracture of the scaphoid (Case III), and only after the careful examination of the plate in preparing this paper did I see my mistake.—E. A. C.)

Another point which may speak for the existence of an old fracture is a distinct atrophy of the proximal fragment. In several of our skiagraphs of old cases this atrophy of the proximal fragment is noticeable. It probably represents diminished blood-supply, owing to the fact that the main nutrient artery of the bone enters the distal fragment. In some of the older cases, also, there is a distinct change in the appearance of the line of fracture. It becomes more smooth and resembles more closely a normal articular surface. The edges of this false joint are often marked by two dark lines in the skiograph which represent an increase of density of the superficial layers of the fractured surfaces of the bone. This appearance is very beautifully shown in Case IX. At the edges of such fractured surfaces there sometimes form the secondary osteophites spoken of as existing on the articular edges of the radius and other carpal bones. In cases where the original injury was of a very severe character, and perhaps the other carpal bones were injured too, as in cases of dislocation of the semilunar with fractured scaphoid, these joint changes have gone on to such a degree that the original outlines of the bones are scarcely recognizable. This is illustrated in Case XIII. Such old misshapen joints may be readily confused with the results of rheumatoid or osteoid arthritis.

TREATMENT OF FRACTURE OF THE SCAPHOID.

It is obvious that treatment of fracture of the scaphoid must be considered according to the time after the injury when the patient comes under observation.

If the patient is seen immediately after the injury, we believe it is possible, by fixation of the joint for a proper period, to obtain union between the fragments. If, however, the wrist is not fixed during the first three weeks after the injury, our observations would tend to show that union does not occur and the fracture remains permanently ununited. We believe that if the fracture does remain ununited, the permanent disability is so great that it seriously interferes not only with the comfort of the patient, but with his ability to enjoy certain games and sports, and also in the case of working-men it limits their working capacity, and hence their ability to earn their living.

In our series of cases there are only three in which the wrist was kept on splints continuously for more than a week after the injury. These cases were VI, VII, XIII. In all three cases union has apparently occurred, as shown by the X-ray taken a year later. In spite of union having occurred in these three cases, however, the final result does not show much improvement as compared with other cases where the fracture has remained ununited. Two of these patients complain of a great deal of pain and tenderness, and the third has still slight impairment of the functions of the joint. It so happened, however, that in one case (Case VI), that of a colored man, there was a medicolegal question which at the writing of this paper had only just come to court; and it is not unlikely that this fact may account for a portion of the man's disability at present. The second case is a machinist, and his occupation obliges him to continually turn and twist the wrist in a way which would tend to irritate it and cause what little soreness there is.

In spite of the poor results in these three cases, however, we believe that these individual patients were not especially favorable subjects, and that in recent fractures we should endeavor by fixation for a number of weeks to obtain union before resorting to excision. At just what time after the injury effort to obtain union by fixation should be abandoned is a very delicate question. We should answer this by saying

that after a fixation of four weeks we should resort to massage, etc., for another four weeks, and if at the end of this time there was no encouraging improvement in function, and the X-ray showed no sign of union, we should advise operation. We do not believe fixation would be worth attempting at all after the eighth week, if, in the meantime, the patient had been using his wrist.

Since, in nearly all of the cases which we have followed, the patients have asserted that no help was received from any of the ordinary treatments of sprain, even when we have recommended those treatments ourselves, we feel that such applications are merely a waste of time, and that when we have decided that an attempt to obtain union by fixation is useless, we should at once recommend excision of one-half or both halves of the bone. Apart from the hopelessness of obtaining union, we find that excision of the bone is indicated to relieve the mechanical irritation caused by the slipping of the fragments on one another, which sets up a chronic synovitis and leads to more or less secondary change in the joint. Thus the joint, instead of improving with use, tends to get worse rather than better, and is ever becoming more subject to renewed injuries and the stiffening effects of chronic arthritis.

When the case is seen many years after the injury, the question is presented in a still different point of view; for instance, Case XV, a personal friend and a surgeon, had broken his scaphoid bone ten years previously in playing football, and since that time had had repeated injuries. This individual had become more or less used to the tenderness and lack of suppleness in his wrist, and since he had become accustomed to it for so many years, the question of excision seems to have a different bearing. In his case, however, because he is fond of athletics, and because the soreness troubles him in his surgical work, we are inclined to advise excision of the bone; although we should hesitate to urge the operation on the ground that a certain amount of compensatory arthritis has already taken place, and even though the source of irritation is removed, the expected result cannot be so good as in a

more recent case in which no secondary joint changes have taken place. On the other hand, in the case of another personal friend, also a surgeon, who had suffered the same injury only three months before, we did advise excision of the fragment on the ground that no secondary changes had taken place, and that we might expect the tenderness, pain, and spasm to be relieved when the source of irritation was removed. The result so far has justified our expectations, and within six weeks after the operation the patient asserted that the wrist was already better than before it was operated on. In the only other case in which we were able to obtain the consent of the patient for operation (Case XVII), the result has been equally satisfactory, although the injury had occurred six months before the operation.

The experience of the other cases which have not had operative treatment has been almost negative; even rest and massage only producing slight temporary benefit, excepting in the acute stage, where the immediate pain and tenderness are certainly helped by the application of a splint. Liniments and counterirritants appear to have no effect.

We have regarded any mechanical method of stimulating callus formation between the fragments as much more dangerous to the wrist-joint than excision, particularly as the three cases, in which we have observed that union has occurred, more or less disability has still remained.

We believe that if operation is refused, the wisest treatment is to merely guard against further injury, and by limiting the use of the joint to endeavor to avoid a chronic arthritis. Many patients have felt relief by wearing a leather wristlet, but this has produced no essential improvement.

The operation for removal of the proximal fragment of the scaphoid bone which we have devised is quite simple and easy of execution either under cocaine or ether. An incision one-half inch long is made on the dorsum of the wrist just to the inner side and parallel to the border of the extensor carpi radialis longior tendon. The skin wound is held apart with retractors, and an incision of about the same length in

the same line made through the annular ligament in the fibrous septum between the long extensors of the fingers and the long extensors of the wrist. This may be done without opening the bursæ surrounding any of these tendons. It will be found that the annular ligament does not gape when the wound is made, so that the incision in the ligament has to be held apart with retractors. Even if the bursæ are opened, as in one of our cases, there is apparently no harmful result. This incision directly exposes the wrist-joint over the proximal half of the scaphoid bone, and if the wrist be abducted, nearly the whole of the scaphoid bone can be brought across the incision. The line of fracture is found on the articular surface towards the radius and a blunt hook introduced into the fissure. In Case XVI, our first case, this line was difficult to find because the cartilaginous surface was broken across obliquely so as to produce bevelled edges which overlapped. With a tenotome the ligaments connecting the posterior portion of the proximal fragment with the capsule of the wrist-joint and with the semilunar are divided. When these have been divided, the fragment still does not move greatly from its position, so that it is necessary to pull firmly upward with a tenaculum through the wound and flex the wrist in order to divide with the tenotome the anterior ligamentous attachments. In both of our cases little flakes of bone were torn from the anterior face of the fragment by the ligamentous attachment and had to be removed after removing the main portion. We found that the distal portion of the scaphoid remains firmly attached to the surrounding ligaments and appears to be capable of taking up the functions of the whole bone.

The wound may or may not be closed. It will be found that the incision through the posterior part of the capsule and annular ligament has no tendency to remain apart, and a stitch in it seems unnecessary. In our first case this was drawn together lightly with one catgut suture and the skin wound left open. The patient had a great deal of pain the first night from distention of the wrist with fluid, whereas in the second case, where we purposely did not close the ligament, there

was practically no pain. In both cases the skin wound was closed by a single subcutaneous suture, which was not pulled tight until the following day in order to let the discharge of serum relieve the tension of the joint, and thus avoid pain.

We advise beginning very slight passive motion within a week in order to prevent adhesions, and at the end of two weeks entire removal of the splints and both active and passive motion of the joint permitted. The use of the fingers may be allowed at the end of a week.

The only unpleasant symptoms which have followed in either of these operations have been in the first case,—a slight irritation of the wound due to a rather excessive discharge of synovial fluid from the joint, and in both cases adhesion of the skin wound to the wound in the ligaments. This has produced a puckering of the skin of the wrist in extension which is somewhat unsightly, although not painful. This, of course, could be easily remedied by removing the scar in the skin and resuturing, but in the next case we should prefer to make the skin incision transverse and the incision in the ligament vertical.

We feel, from the study above presented, that the following conclusions as to the treatment of simple fracture of the scaphoid are justified:

I. Cases which have not been treated or which have been treated as sprains, by a short period of fixation followed by massage, active and passive motion, etc., seldom, if ever, have union of the fragments.

II. If the joint is kept fixed for a number of weeks immediately after the injury, union may occur, but the functional result is not perfect, although better than in cases of non-union.

III. It is too late to obtain union if fixation is not attempted within a few weeks after the injury.

IV. Excision of the proximal half of the broken scaphoid promises a better ultimate result than any other form of treatment.

V. Since operation, nevertheless, is an undesirable risk, a reasonable attempt should be made to obtain union by fixation, if the case is seen soon after the injury.

VI. Operation should not be delayed many months, because secondary joint changes may occur and chronic arthritis result.

VII. The advisability of operation in cases of long standing is doubtful, and must be decided by the amount of disability present in each individual case.

CASES OF SIMPLE FRACTURE OF THE SCAPHOID.

CASE I.—J. G.; boiler-maker; aged thirty-two years; male. This patient was injured in a street fight, July 6, 1897. Among other injuries, he was kicked in the left wrist by one of his assailants. He came to the Out-Patient Department of the Massachusetts General Hospital the next day. There was considerable swelling over the wrist and some tenderness, but no apparent fracture. He was not examined by the X-ray. A diagnosis of sprain was made, and splints and bandages applied, and he was told to return in a week. He did not return, but removed the splints in a week and went to work. He came to the hospital again in December, 1897, complaining that the wrist had troubled him ever since the injury when he did hard work, and, as he is a boiler-maker, this means most of the time. At this time there was no swelling or deformity; flexion and lateral motion were noted as perfect, but extension was limited about one-half. He said the wrist was stiff when he began work in the morning. The X-ray showed a fracture of the scaphoid bone in its middle third.

CASE II.—M. H.; shoemaker; aged twenty-seven years; male. This patient came to the Massachusetts General Hospital, March 24, 1899. He said that for four years he had had pain in his right thumb and weakness in his wrist. The pain went away with rest, but came on again when he worked. For four days before he came to the hospital there had been a swelling on the back of the hand. Passive motion was interfered with by stiffness of the joint, and there was local swelling at the base of the thumb. There was no numbness or motor weakness. He gave no history of having had an injury, but the X-ray showed a fracture of the scaphoid bone, with some old injury of the lower end of the radius as well.*

CASE III.—N. W. J. H.; electrician; aged thirty-three

* For the notes on this case and Case I we are indebted to Dr. F. G. Balch, although Case I was seen by E. A. C.

NORMAL HAND OF CASE 15.
JAN. 30, 1901.

CASE 1
DEC. 7,
1901.

CASE 2.
MAR. 24, 1902.

CASE 3.
MARCH 1901.

CASE 4. (a)
MAR. 22, 1901. (ant.)

CASE 4. (c)
APR. 15, 1901. (post.)

CASE 5. (a)
DEC. 11, 1901. (ant.)

CASE 5. (c)
JAN. 25, 1902. (front)

CASE 5. (c)
MAR. 26, 1902. (ant.)

CASE 6. (a).
MAY 19, 1901.

CASE 6. (c).
NOV. 1901.

CASE 7.
MAY 5, 1902.

years; male. This patient first injured his right wrist by falling from a high bicycle on his extended hand in the summer of 1895. He does not remember that he received any treatment for it. The wrist remained lame and troublesome, and in March, 1901, he again hurt it while stretching a wire in doing some electrical work. At this time he was using a screw-driver both before and after the injury. He thinks this aggravated his symptoms. About this time he came to the hospital under my care, and was treated by the application of a leather and, later, a steel splint. My diagnosis at this time was an arthritis of the joint between the trapezoid and scaphoid, and, in spite of the fact that at this time I had already seen a number of X-rays of fractures of the scaphoid, I did not make a positive diagnosis. It was only recently, on looking over his plate with other X-ray plates, that I felt confident of the diagnosis. (E. A. C.) The patient, by letter, on April 17, 1904, says that the wrist still troubles him, especially in such motions as using a screw-driver and using pen and ink. He says that now there is no swelling or tenderness "externally;" that it aches and feels sore internally after a few hours' work, and in much less time if the work is heavy. He cannot write legibly if he tries to write quickly, and the wrist is much less useful for "every purpose."

The X-ray taken on the 15th of March, 1901, shows an old fracture of the scaphoid bone, with an overlapping of the fragments and a decided amount of secondary bony change in the region adjacent to the trapezoid. The X-ray also suggests that there was a third small fragment as well as the two large ones. The fracture occurred at the middle of the bone. Unfortunately, the only skiagraph we have was taken in the straight position instead of in adduction.

CASE IV.—A. D.; teamster; aged thirty-nine years; male. This patient presented himself at the Massachusetts General Hospital on the 22d of March, 1901. About an hour before, his thumb had been injured by having a truck roll over it. An X-ray taken at the time showed an oblique fracture of the proximal phalanx of the thumb of the right hand, and incidentally a fracture of the scaphoid bone; but since there was a considerable deformity of the adjacent portion of the radius, it was evident that the fracture of the scaphoid had occurred some years before. The patient could remember no injury to his wrist previously. The

fracture of the thumb was set and convalescence was uninterrupted. He returned for examination on April 5, 1904. The bony landmarks in the neighborhood of the scaphoid were much altered from their normal relation, and his power of flexion, extension, and abduction were slightly limited; adduction was normal. He stated that the wrist did not interfere at all with his work.

The X-ray taken on the 22d of March, 1901, shows a fracture of the scaphoid at the junction of the middle and proximal third. The shadow of the distal fragment is distinctly more dense than that of the proximal fragment. The line of separation of the two fragments is not clear. The plane from which the X-ray was taken suggests that the fragments overlap, so that the rays did not come directly through the gap between them. There is a distinct secondary alteration of the line of the lower end of the radius in the portions which come in contact with the deformed scaphoid.

The X-ray taken on April 5, 1904, shows much the same condition as that taken in 1901, except that the scaphoid appears to have partially united; although this appearance may be due to the overlapping of the fragments. The scaphoid of the other side shows no indications of a weakened area in the region where the other is broken. We cannot assert positively that this was not a case of bipartite scaphoid, but the presence of arthritic changes indicates very strongly that it was a traumatic condition.

CASE V.—H. S. F.; student; aged nineteen years; male. In the latter part of October, 1901, this patient "sprained" his left wrist in playing foot-ball. Three days later he sprained it much more severely. There was great pain and swelling and tenderness over the wrist-joint. All motions were painful. The surgeon of the foot-ball squad considered it a sprain, and the wrist was kept on a splint for about a week, after which the patient was allowed to use his hand. Although there was some improvement in motion, the tenderness and swelling still continued, and about two months later the patient consulted me at my office.

At the time I saw him there was decided swelling over the radial half of the wrist-joint, great tenderness over the scaphoid bone, particularly when pressure was made in the anatomical snuff-box with the wrist adducted. There was marked spasm

in extension, so that the wrist could only be extended for 10° or 15° without giving great pain. I made a diagnosis of fracture of the scaphoid and confirmed it with the X-ray. As two months had elapsed since the injury and there appeared to be no sign of union, I thought it was probable that the fracture would remain ununited, and, therefore, only kept the patient on splints for two weeks, at the end of which time I began massage. This was continued for several months, but the condition of the wrist was not greatly improved. The disability remained so great that, in consultation with Dr. A. T. Cabot in the spring of 1903, we thought it wise to break up the adhesions under ether so as to allow more free motion. This was accordingly done. When the muscles were relaxed under ether, it was found the wrist could be extended through its normal arc without any great force being used. Twice after this within the ensuing month the wrist was forcibly extended without giving ether, and, though the spasm was very marked, the normal arc of motion could be gone through. The pain, however, was excruciating, and a great deal of swelling and tenderness followed without a proportionate amount of benefit.

At the present date, March 28, 1904, the condition is not greatly different from that when I first saw him two years ago. There is still a fulness in the radial half of the wrist-joint and decided alteration of the bony landmarks; there is acute tenderness in the snuff-box, and any motion which forces the hand backward in extension beyond an angle of about 40° is extremely painful and checked by involuntary spasm. Flexion and adduction are normal, but abduction can only be carried a few degrees from the straight position.

The X-ray in December, 1901, showed a transverse fracture in the middle of the left scaphoid. Several months later, January 28, 1902, there appeared to be a collar of bony callus formed about the seat of fracture, but no union between the fragments. On March 26, 1904, the X-ray shows a still larger bony callus which seems to arise chiefly from the distal fragment.

CASE VI.—M. J.; waiter; aged thirty-three years; male; colored. On May 13, 1901, this patient fell from a staging on his flexed right hand. He went to a doctor at once, and was told that he had "sprained" the wrist. The next day he came to the Massachusetts General Hospital, Out-Patient Department, where an X-ray was taken showing fracture of the scaphoid, and

he was put on splints for about three weeks and afterwards bandaged and massaged. As far as he can remember, it was under treatment eight weeks.

On February 8, 1904, we examined the patient again. Considerable alteration of the bony landmarks was found, and there was no local swelling, but decided tenderness. He had about one-half of the normal extension of the wrist-joint and slight limitation in flexion; abduction and adduction were normal. He said that it interfered with his work a great deal; that he could not carry heavy weights in that hand; that he could not press forward very hard, as in opening a heavy door. Extreme motions in all directions caused pain in the region of the scaphoid. He thinks the wrist is a little better than it was a year ago. Since this patient was suing for damages for this injury, we feel that he may have somewhat exaggerated the amount of disability.

The X-ray at the time of the original injury showed a fracture exactly in the middle of the right scaphoid, and a small fragment on the radial side of the bone in addition to the two main fragments.

The X-ray in November, 1904, shows that union of the bone has taken place, but there is considerable change in the normal outline. The middle fragment on the radial side has formed a small protuberance.

CASE VII.—J. C.; electrotyper; aged eighteen years; male. In November, 1901, J. C. "hurt" his left wrist in playing football, and again "injured" it from a fall from a bicycle May 7, 1902. He regarded the injury as a sprain on both occasions, and did not consult a doctor until May 10, 1902. He wore a wrist-strap after the first injury, but no splint was applied. On May 10, 1902, he came to the Massachusetts General Hospital, Out-Patient Department, under my care. He was kept on splints for four or five weeks, and then massage was used for a short time afterwards. At the time I saw him the symptoms and signs were characteristic of fracture of the scaphoid, *i.e.*, localized swelling, tenderness, spasm in extension, all motions somewhat painful, particularly if forced beyond the degree in which involuntary spasm began. There was no ecchymosis. The patient said that at the time of both injuries the pain had been extreme. The treatment in this case seemed to be quite effective, and at the time of discharge the incapacity was not as great as is often seen.

This same patient in July of the same year hurt his right wrist, and possibly suffered the same injury in his right as he did in his left wrist. That of the right was caused by catching a swift base-ball, which forcibly extended his wrist. The injury seemed to him so nearly like the original injury to his left hand, that he made his own diagnosis, and was able to assist his own physician in the treatment, and did not come to the hospital. He kept the wrist on a pasteboard splint for three weeks before beginning to use it, and had no massage after leaving off the splint. Examination of the patient was again made on January 29, 1904. The left wrist was slightly tender, not swollen, and the limitations were only slight. His right wrist was, however, decidedly tender; extension and abduction were limited one-half, and the other motions were considerably more impaired than those of the left. There was slight alteration of the bony landmarks. He says that neither wrist interferes with his work, but that he notices both in unusual exercise, especially when fooling with other men or when playing games.

The X-ray of the left wrist in May, 1902, shows a subluxation of the semilunar and a chip off its posterior edge, as well as a fracture of the scaphoid. It is unfortunate that we are unable to reproduce the X-ray in January, 1904. It showed no sign of fracture of either scaphoid, and it is particularly interesting that in this case the epiphyseal lines in the radius and other bones have united as well as the fractures of the scaphoids. This case, from the fact that he may have had a fracture of both scaphoids, and that the scaphoids have united at the same time when the epiphyseal junction took place, speaks for Professor Dwight's hypothesis.

CASE VIII.—E. G.; cigar-maker; aged thirty-three years; male. About fourteen years ago, E. G. had a marble slab fall on his left wrist. A day or two later his hand was forcibly extended by indirect violence from a fall (?). He went to the Boston Dispensary and had applications (?) made to the wrist for about a week. Since this time he has had more or less trouble with the joint, and came to the Massachusetts Hospital on the 22d of April, 1902, to see if anything could be done for it. There was localized tenderness and swelling over the scaphoid and pain on extreme flexion or extension of the wrist. There is no record of the treatment that he received at the hospital at that time. I saw the patient again on January 29, 1904, and found that tenderness

over the scaphoid was still present. There was no swelling, but the bony landmarks were considerably altered as compared to the other wrist. Flexion and adduction were normal, but extension and abduction were slightly limited. The patient said it did not interfere with his work, but occasionally hurt when forcibly extended.

The X-ray shows a united fracture of the scaphoid in the middle third. There appears also to have been some compensatory change in the shape of the articular surface of the radius. The condition of the bone in the X-ray of 1904 is practically the same as that seen in 1902.

CASE IX.—P. J. B.; clerk; aged forty years; male. On the 25th of November, 1902, this patient struck a man in the jaw with his closed fist, so that the blow was felt almost entirely on his bent knuckles. He came at once to the hospital. At this time the base of the metacarpal of the right thumb was swollen and tender, and a fracture was diagnosed and confirmed by the X-ray. Incidentally, the X-ray showed an old fracture (?) of the scaphoid at the junction of the middle and proximal third. Owing to the manifest tenderness of the recent fracture of the metacarpal of the thumb, the scaphoid injury was overlooked, and it was not until the following year, in looking over a large number of X-ray plates, that we noticed the scaphoid lesion and sent for the patient.

We examined him on February 10, 1904, with especial reference to the lesion in the wrist; although the fracture of the metacarpal had left a considerable deformity (Smith's fracture). The patient said that he might have injured his wrist years before, but could give no definite history of it. There were still decided swelling and tenderness in the radial half of the wrist-joint, great alteration of the bony landmarks, and all motions of the wrist greatly limited. He said that it did not interfere with him in his work, but did hurt him to row, and it often hurt when he was playing games or fooling with other men. The thickening over the scaphoid was so great as to resemble the fusiform swelling of tuberculosis. The X-ray in this case is very interesting. There appears to have been a fracture at the junction of the middle and proximal third of the scaphoid, following which a secondary deformity of the joint has taken place, and the adjacent bones show the ragged condition so often seen in osteoid arthritis. It is noticeable that the proximal portion of the scaphoid is greatly atrophied as compared to the distal portion, the adjacent edge of which has evi-

CASE 8 (c)
JAN 24 1903

CASE 9
NOV 24 1903

CASE 10
JAN 24 1903

CASE 11 (c)
APR 11 1903

CASE 11 (c)
APR 11 1903

CASE 12 (c)
APR 11 1903

CASE 12 (c)
FEB 15 1903

CASE 13 (c)
MAY 19 1903 (right)

CASE 13 (c)
APR 29 1903 (left)

CASE 14
JAN 24 1903

CASE 15
JAN 24 1903

CASE 16 (a)
APR 15 1903

dently formed a new bony layer at the fractured surface as shown by a dark line in the X-ray. The disability in this patient's case was so great as to warrant my advising excision of the scaphoid, but the operation was refused. As in Case IV, we cannot assert positively that this may not be a bipartite scaphoid.

CASE X.—F. E.; machinist; aged forty-one years; male. In February, 1903, F. E. fell off a load of logs and landed with his hand under him, hurting it severely. He states that all motions of the left wrist were very painful. There were local swelling and tenderness over the joint. His doctor treated it with antiphlogistine for two or three weeks, but since the wrist continued sore he came to the Massachusetts Hospital, and it was put in splints for about two weeks. His local doctor had considered it a sprain. The X-ray taken at the hospital showed a fracture of the scaphoid, although not as clearly as it often does, since the fragments were overlapped.

We again examined the patient on February 12, 1904, and found decided localized swelling and tenderness, alteration of the bony landmarks, and limitation of all the motions of the wrist to about one-half the normal amount. He stated that it did not interfere much with his work, but he noticed it every day; he could lift but could not twist with that hand; he could not push open a heavy door, and it constantly became sore after use. The thickening about the scaphoid was so great as to induce us to advise him to have the proximal portion of the scaphoid removed. He was not willing, however. The X-ray taken on June 27, 1903, showed considerable atrophy of all the bones of the wrist and fracture of the scaphoid in its middle third, with overlapping of the fragments and a questionable partial subluxation of the semilunar. The X-ray on the 12th of February, 1904, while not clear as to the point as to whether the fracture has united or not, shows a decided alteration as compared with the other wrist.

CASE XI.—E. C.; hostler; aged twenty-five years; male. In 1900 he fell on his right wrist and sprained it. On April 6, 1903, he was thrown by a horse and fell on the right wrist with the hand extended. He came at once to the hospital, and examination showed local tenderness and swelling over the scaphoid, spasm in extension, and pain in all motions. The X-ray showed a fracture of the scaphoid which was evidently not recent, as the outlines were smoothed off and presented the appearance char-

acteristic of an ununited fracture rather than a fresh fracture. In the lateral view a small fragment, about the size of a No. 6 shot, was seen opposite the posterior edge of the semilunar bone; but it was impossible to tell from which bone this fragment had been torn. The patient was kept on splints for about three weeks. No further record of the progress of his case was kept until January 30, 1904, when he was again examined. There was no swelling or tenderness unless extreme motions were forced. There was decided alteration of the bony landmarks. Flexion and extension limited one-half. There was more or less limitation in adduction and abduction. He said that it did not interfere with his work at all, but the characteristic guarding spasm in extension showed there was decided irritation of the joint.

An X-ray taken on the 4th of April, 1904, shows practically no change from the one taken in the previous year.

CASE XII.—E. W. B.; railroad employé; aged thirty-nine years; male. On April 13, 1903, he fell from the top of a freight-car with his right hand doubled up underneath him. He does not know whether his hand was flexed or extended. He came at once to the hospital, and the X-ray showed a transverse fracture of the scaphoid and a Colles fracture. The character of the X-ray of the scaphoid makes it probable that the fracture was an old one and did not occur at this injury. Inquiry later revealed the fact that the cause of the fall from the car was really due to a weakness of the right wrist caused by a fall from a chair three months before. The original injury was supposed to have been a sprain, and he had worn a splint on the wrist for a week, but it had never felt right again. At the time I saw him at the hospital I treated him for the Colles fracture especially, because there appeared to be no especial pain or tenderness over the scaphoid. He was kept on splints, silicates, etc., for about six weeks.

On February 15, 1904, I examined him again. There was no tenderness over the scaphoid, but I found a very slight thickening and a slight deformity over the Colles fracture which obscured the normal relations of the scaphoid. The motions of the joint were only half of the normal, and the patient said that the wrist interfered with his work considerably. Constant strain tired him. He noticed discomfort from it in turning a door-knob or pressing against the wall. The X-ray in April, 1903, shows a typical recent Colles fracture with posterior displacement, a small chip of bone

off the ulnar styloid, and a transverse fracture through the middle of the scaphoid. There are compensatory changes in the adjacent surface of the radius.

In the X-ray of February 15, 1904, the same changes are noticeable, except that the Colles fracture has entirely healed. The scaphoid remains ununited. There is no sign of any interval corresponding to the point of fracture in the opposite scaphoid.

CASE XIII.—W. B.; artesian-well driller; aged forty-nine years; male. On April 21, 1903, while he supposed his machine was shut down for oiling, he had his right hand in the apparatus, which started up unexpectedly and caught his wrist and violently flexed it. Three days later he went to the Massachusetts Hospital, where the wrist was put on splints for five weeks and bandaged for two weeks longer. The X-ray at this time showed a questionable fracture of the scaphoid; there was local tenderness and swelling, especially in extension; slight ecchymosis on the palmar side of the wrist, and all motions were painful.

The patient was examined on February 18, 1904, and the motion of the wrist found to be excellent, except slight limitation in flexion and extension and slight alterations of the bony landmarks. He said that it did not interfere with his work at all.

It so happened that this same patient had injured his left wrist by having it caught in a cable on shipboard fourteen years ago. There exists at present a marked deformity and bony enlargement of the wrist, with more tenderness over the scaphoid than in any other portion. He can work with it without any trouble, but any blow against the left thumb gives him pain in the region of the scaphoid. The wrist is almost stiff, having only a few degrees of flexion. The X-ray in April, 1903, of this case was interpreted at the time positively as showing fracture of the scaphoid. From the X-ray alone in this case I should be unwilling to make a positive diagnosis, but I believe that the lesion in both wrists of this patient was fracture of the scaphoid in its middle third. The X-ray taken in 1904 seemed to indicate that there has been union of the scaphoid in the right wrist.

CASE XIV.—G. T. L.; dentist; aged twenty-eight years; male. This patient was a student in the Medical School at the time I was first interested in fractures of the scaphoid, and a diagnosis was made at that time. My notes on the case were lost, and I again wrote to him in April, 1904. The following letter from Dr. L. gives his own version of the history. "In answer to

your inquiry, I would say that the fracture of the scaphoid bone of my right wrist happened during the fall of 1896. I was at that time a student at Lawrence Academy, and, while performing on the horizontal bar in the gymnasium there, I slipped and fell to the mattress, a distance of seven feet. Falling forward, I extended my hand as if to save myself, and struck with my whole weight on my right hand and extended it backward. I attempted to continue with the performance, but was unable to use the hand. I visited a physician, who diagnosed it as 'a simple fracture' and bandaged it. This was all the treatment that it had. Your attention was called to it while I was attending a clinic at the Female Out-Patient Department, Massachusetts General Hospital. The same condition is present as at the time that you saw it . . . It causes me the greatest trouble when writing and in extracting teeth, and at times the pain is so severe that I can hardly grasp the forceps. It interferes in any work that requires grasping an object and in pulling, as in extraction of teeth. It soon tires by long use, as in dissecting and writing."

My recollection of the examination of this wrist is that his motions were more free than the usual run of scaphoid cases. He says in his letter that there is no swelling now, but there is "a sort of dislocation, as the fragments slip over one another." I remember that when I saw him at the hospital this snapping of the fragments suggested that one of the tendons was dislocated, so that it snapped in and out of place. I am not sure whether it is really the bone which causes the snapping or one of the tendons.

The X-ray shows an ununited fracture of the scaphoid at the middle and proximal third, with probably a third fragment coming from the middle portion.

CASE XV.—H. W. B.; physician; aged thirty-four years; male. In September, 1893, while playing foot-ball, his right wrist was forcibly extended. He consulted a physician within a few hours, and a diagnosis of "sprain" was made, and a leather wristlet was applied, which he wore for about two months. Meanwhile he kept on playing foot-ball in spite of the pain and tenderness. There was marked local swelling in the scaphoid region, spasm in extension, and all motions were painful. The wrist has never been well since, although he has always been able to use it for ordinary work, being occasionally obliged to rest it on account of the swelling, pain, and tenderness. It is subject to injury from any force which suddenly extends the wrist. Within a few

months of the present date, January 30, 1904, there has been one of these exacerbations. There is no distinct swelling and local tenderness over the scaphoid bone, but there is a decided change in the bony landmarks, and all the motions of the joint are slightly limited. There is distinct spasm as the wrist approaches extreme extension. It is, and has been, an annoyance to him in his work, in certain positions hurting more than others, and even at times preventing the use of it for a few moments. Pressure in the snuff-box is intolerable. The X-ray shows a transverse ununited fracture at the junction of the middle and proximal third of the scaphoid. The bony structure of the proximal portions is not as clearly defined as in the distal, and it appears to contain an area about the size of a No. 6 shot in which the trabeculae are destroyed. There are compensatory changes in the articular surface of the adjacent portions of the radius. The other wrist is normal.

CASE XVI.—W. C. S.; physician; aged thirty-one years; male. On January 20, 1904, while in his bath, he fell on his extended right wrist, so that the full weight of his body was thrown onto the palm of his hand. There was extreme pain at once, marked local swelling over the scaphoid, tenderness and spasm in extension, very faint ecchymosis, and all motions were painful. Three hours after the injury the wrist was put upon a mill-board splint and bandaged. The lesion was considered a sprain, so that the splints were worn on and off for a week, being removed at times to allow the use of the wrist. After a couple of weeks, as there was no great improvement, a fracture of the scaphoid was suspected, and the patient examined his wrist with a fluoroscope, but the fracture was not seen. The symptoms continued, and on my examination on March 9 there was still evident swelling in the radial half of the wrist, decided tenderness in the anatomical snuff-box, and a slight change in the bony landmarks as compared with those of the other wrist. Motions were somewhat limited and checked by spasm in extreme positions, and the patient complained of pain and weakness in any motions requiring a moderate amount of force.

On March 15, 1904, the patient writes as follows: "All motions of flexion and extension and adduction are very painful when forced beyond a certain extent. The whole treatment has been much abused and practically *nil* in my case. The wrist grows gradually but slowly better, and has had no serious setback."

The X-ray shows a transverse fracture of the right scaphoid

at the junction of the middle and lower third, with a moderate amount of displacement of the proximal fragment. The scaphoids of both wrists in this patient are large. The structure of the bone in the left wrist shows no indication of the existence of a bipartite formation. I advised operation, and performed it as follows on April 25, 1904, under cocaine and with the assistance of Dr. Henry M. Chase.

A tourniquet was placed about the upper arm and about three drachms of one-half per cent. solution of cocaine injected on the dorsum of the wrist in the region of the extensor tendons. An incision one-half inch long was made between the common sheath of the radial extensors and the long extensors of the fingers. The incision was carried through the posterior annular ligament directly into the wrist-joint, with its upper end at the edge of the articular surface of the radius. Retraction of the cut edges of the annular ligament exposed the scaphoid bone. When adduction was made, a fine line of fracture was seen transversely across the articular surface of the scaphoid. A blunt hook was introduced into this fissure, and traction on the hook moved the whole bone instead of one fragment, so that it was evident that either partial union had occurred or that the ligaments held the two fragments so closely together that they moved as one piece. No crepitus could be obtained, and the fragments could barely be made to move on one another. The attachment of the proximal portion of the bone to the dorsal ligament was then divided with a tenotome, and also the attachment of the ligament uniting the scaphoid to the semilunar. A blunt instrument was then introduced into the crevice of the fracture and the distal fragment pried out of its bed. In doing this, the fragment was apparently torn in halves. It was impossible to tell whether this fracture was due to the manipulations of extracting the fragment or whether it already existed. When this fragment was removed, another fragment lying to the palmar side was seen still more or less firmly attached to the distal portion of the bone. This fragment, also, was easily pried out of its bed, and freed by a division of some fibrous bands holding it to the anterior portion of the joint. When both fragments had been taken out, the fractured surface of the remaining portion of the scaphoid was in plain view, and presented the appearance of a fresh fracture. There appeared to be no attempt at callus formation either on the fragment that was left in or on the fragment that was taken out,

with the exception of a few granulation-like masses on the surface of the fragment which was removed.

When the tourniquet was removed, there was a great deal of oozing from the wrist-joint, so that it was felt unwise to close the capsule tightly, particularly as the incision in the ligament seemed to fall together naturally of itself and have no tendency to pull apart. A subcutaneous stitch was placed in the skin incision and one catgut stitch in the incision in the ligament. The subcutaneous stitch was not pulled tight, so as to allow free oozing into the dressing, and the arm was put upon a palmar splint extending to the elbow, and a voluminous dressing applied. The patient said that except for the tightness of the tourniquet the operation gave him no pain.

A letter from the patient on April 28 says, "Just a word to let you know that my wrist is now getting along finely. For the first twenty-four hours the pain was very considerable, much more than I supposed it was going to be, so that I took one-half a grain of morphine that night."

June 4, 1904. He wore the full length splint for five days, and then shortened it to the metacarpophalangeal joints and wore it for a week more, after which he wore a bandage for three days, thus after two weeks he wore no apparatus at all on the wrist. The skin wound did not heal by a perfect first intention (but did not become septic), so that there was a slight ooze from it for about two weeks. About the wound there was considerable thickening of the soft parts and some redness, but no discharge of pus. The swelling and redness have gradually subsided, but they are still present to a considerable extent. He has had perfect use of the fingers since removing the splint, and the wrist feels somewhat better than before the operation.

Examination shows that the scar is rather humped up, red, and irritable looking. The skin scar is adherent to the ligamentous scar, so that when the wrist is extended there is a reduplication of the skin in folds. His adduction and abduction are normal. Flexion within ten degrees of normal and effort at further flexion not painful. Extension is only one-half normal, and forced extension is still painful as in an ordinary scaphoid case. He says that a straight pull or a grasp does not hurt him, but in certain positions of twisting or where leverage is made on the thumb there is decided pain, particularly when his wrist is relaxed and the force unexpected. He has not attempted to play golf or

tennis, as he still feels that the wrist is too weak. It does not bother him, however, in operating.

A letter from the patient on October 11, 1904, says, "In answer to your letter of the 2d inst., I will give the following report. Present condition of wrist.

"*Adduction* complete; slight pain on forcible adduction; slight tenderness on pressure over point of the scaphoid, but less than three months ago.

"*Abduction* slightly limited, and pain on forcible abduction.

"*Flexion* very slightly limited; no pain on forcible flexion, but a pull on the adhesions of the scar.

"*Extension* slightly limited; less so than three months ago; slight pain on forcible extension.

"In other words, ordinary movements of the wrist are free and without pain, almost normally strong in grasp, except where there is too much tax in a position of adduction.

"In my hospital service of three months' operating this summer I was not inconvenienced at all by the wrist, except at first would feel pain on certain motions requiring leverage at the wrist. Now the only times of inconvenience or pain are in trying to use the wrist with too great force either in pushing or lifting.

"Improvement is still taking place, so that I feel that six months more will give me almost a perfect wrist."

CASE XVII.—F. U. B., Jr.; clerk; aged twenty years; male. On October 1, 1903, he fell backward in a boat, striking the back of his right wrist against the side of the boat. He says that there was much local tenderness and pain at the time, and all motions of the wrist were painful. There was no ecchymosis.

He was brought to my clinic on April 28, 1904, by Dr. J. H. Wright. At this time there was some thickening about the scaphoid bone and marked tenderness in the anatomical snuff-box. There was no perceptible change in the bony landmarks, but slight limitation of flexion. Extension was limited to about one-half, adduction and abduction were normal. There was decided spasm in extension, and pain if any motion was forced beyond the degree easily obtained by active extension. It chiefly interferes with him in pushing, as in lifting on the arm of a chair when he rises from a sitting posture, or pushing open a heavy door. It hurts him to twist the wrist. The X-ray in this case shows a fracture of the right scaphoid at the junction of the middle and proximal third.

The X-ray suggests that there are three fragments, but only



CASE 16 (6)
JUNE 4, 1904.



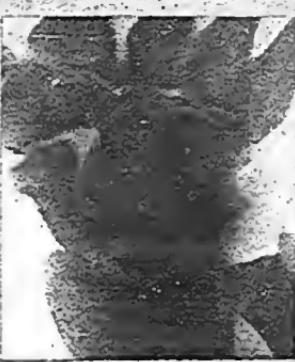
CASE 17 (6)
APR. 26, 1904.



CASE 17 (6)
OCT. 1904.



CASE 18.
APR. 15, 1904.



CASE 18
NORMAL.



CASE A.
1896.



CASE B.
JUNE 1, 1904.



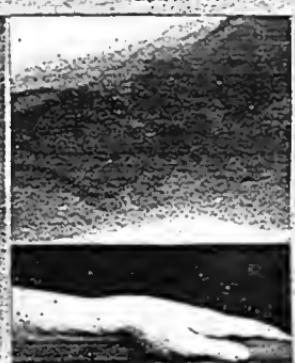
CASE C.
DEC. 4, 1897.



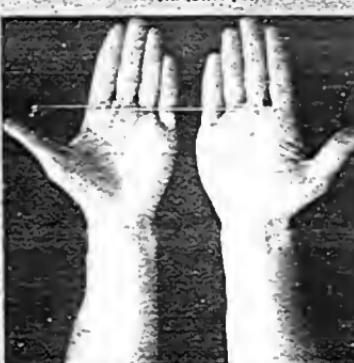
CASE D.
JAN. 31, 1898.



CASE E.



CASE F.



CASE F.

two can be positively affirmed. From the X-ray it is impossible to tell whether union has actually occurred. The other scaphoid shows no departure from the normal. Operation on April 30, 1904. Ether. Dr. H. M. Chase assisting.

A longitudinal one-half inch incision was carried through the posterior annular ligament of the wrist between the long extensors of the wrist and the extensors of the fingers. The upper end of the incision was just at the edge of the lower end of the radius. Retraction exposed the radial surface of the scaphoid bone. There was an excess of synovial fluid in the joint, although no distention. With slight abduction a transverse fracture was seen across the articular surface of the scaphoid bone at the junction of the middle and lower third. When the wrist was moved, it was observed that the two fragments moved separately, though to a very slight extent. The ligamentous attachments of the proximal fragment to the dorsal ligaments of the wrist and to the semilunar bone were divided with a tenotomy. A blunt dissector was introduced into the fissure between the two fragments and the proximal fragment torn from its anterior attachment and delivered through the wound. A few crumbs of bone adhering to the anterior ligaments were then removed with the scissors, and a small rice-like body which was free in the joint also removed. The free surface of the distal portion of the bone which still remained in the joint had the appearance of a recent fracture, except that the surface was more pale and smoother and seemed to be covered with synovial membrane. It did not bleed freely.

The ligaments divided by the incision were not stitched together because they seemed to approximate closely enough without stitches. A subcutaneous silkworm-gut stitch was passed through the lips of the skin wound, but was not tightened. This was done to allow the escape of oozing blood and synovial fluid from the wound.

The patient had a comfortable night, very little pain, and did not require morphine. The subcutaneous silkworm-gut stitch was pulled tight the following day.

May 3. Wound examined. Slight swelling of the wrist and superficial redness. Temperature, 99.5° F.; pulse, 100. No pain.

May 7. No sepsis. Splint shortened to metacarpophalangeal joints.

May 9. Fingers move perfectly without pain, and wrist,

though still slightly swollen, is not tender. Fifteen or twenty degrees of active motion without pain. Splint reapplied.

May 26, 1904. Considers wrist better than before operation. Still spasm in extension but not so marked. Flexion within twenty degrees of normal. Extension forty-five degrees. No pain in ordinary use unless motions are forced.

October 23, 1904. Perfectly satisfactory wrist; does not interfere with work or gymnasium exercises. No tenderness in scar or in snuff-box. Extension within ten degrees and flexion within five degrees of normal. Slight tenderness, but no spasm, when forced motions are made. Snuff-box feels smaller than normal.

CASE XVIII.—C. M.; yacht rigger; aged thirty years; male. Came to Massachusetts Hospital, April 15, 1904, for treatment of secondary syphilis. Incidentally, he called the attention of Dr. R. B. Greenough, under whose charge he came, in the Genito-Urinary Department, to his right wrist, which gives him a good deal of annoyance.

He said that in the winter of 1897 he was skating fast and ran into another man, so that his flexed (?) wrist caught the blow and was bent forcibly between his own chest and the body of the individual who ran into him. He did not go to a doctor, but applied liniment to the wrist for two months, and then went to work. He has continued at work steadily until two days ago. The wrist had been practically well until a week ago. He has always had limitation of motion, but no pain. He does not attribute the recent soreness of his wrist to any especial injury.

The symptoms were so characteristic of fracture of the scaphoid that Dr. R. B. Greenough called my attention to it, and an X-ray confirmed the diagnosis. There was the characteristic swelling and tenderness over the scaphoid bone, particularly in the snuff-box; all extreme motions were painful, and extension beyond fifteen degrees was prevented by involuntary spasm. The wrist could be flexed about two-thirds the normal amount before it gave pain.

The X-ray shows a transverse fracture of the scaphoid in its middle portion, with very little separation of the fragments. There is little secondary change about the edges of the fracture, which exactly resembles a recent case. There seems to be no attempt at callous formation. The scaphoid of the other wrist shows no sign of a fault in its bony structure.

(To be continued.)